A Low-Cost High-Speed Inspection System for Pharmaceutical Capsules

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Introduction

- Project in collaboration with Pharmaphil Inc. and the Ontario Centre of Excellence
- Solution to fix poor quality control of manufacturing process
- Retrofitting of existing capsule inspection system, Optisorter

Current Quality Control

- Manual inspection performed on random samples from each run.
- Pre-packing inspection performed manually at high speed.
- Defective product is being shipped

State of the Art

MVT TABLET INSPECTION MACHINE

- Few capsule inspection systems exist
  - Very Expensive
 - Most use existing vision systems such as Cognex

Optisorter

- German designed system that inspects capsules
- Highly dated system but provides good mechanical base
- Electronics must be replaced
  - Analog PAL cameras
  - Equivalent 80286 CPUs
- Many controls and instrumentation can be reused
  - Electronic pneumatic valves
  - Stepper Motor / Controller
  - Power Supplies
  - Switches / Lamps

Optisorter
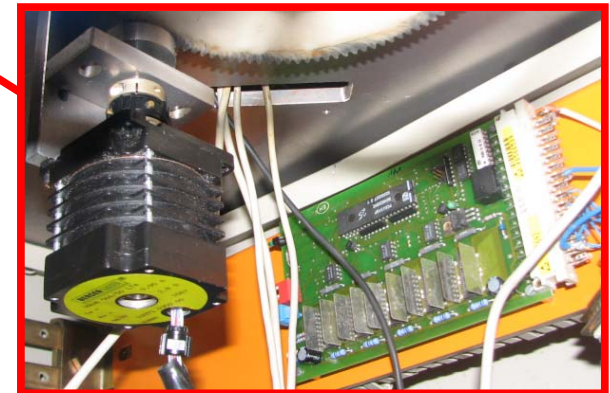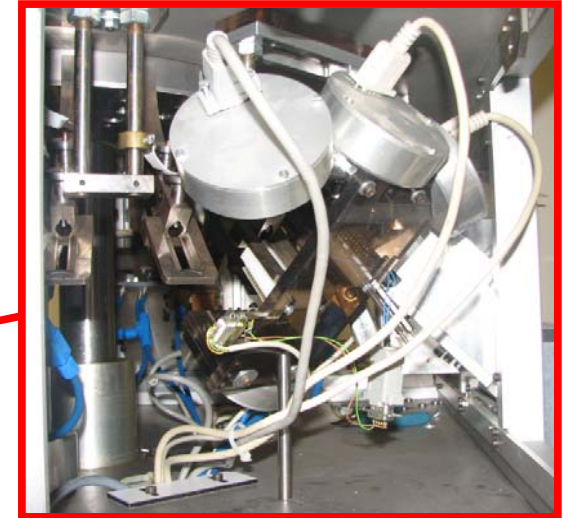
Optisorter

System Summary

- Four quadrants work in parallel to inspect 1000 caps/min.

- Each quadrant has 3 cameras to capture a 360° view of the circumference of the capsule (120° separation).
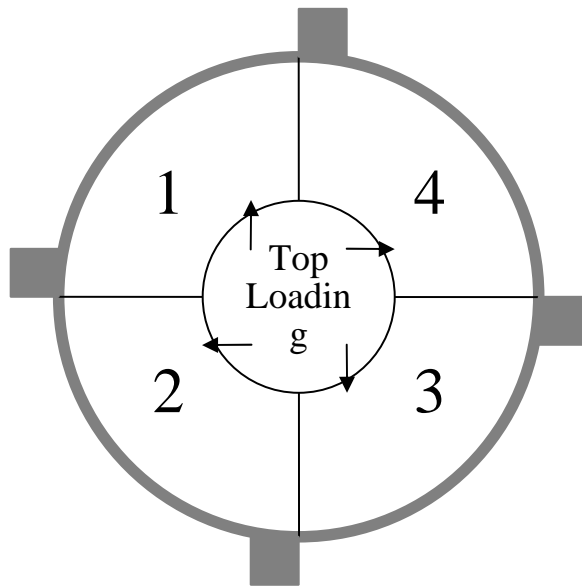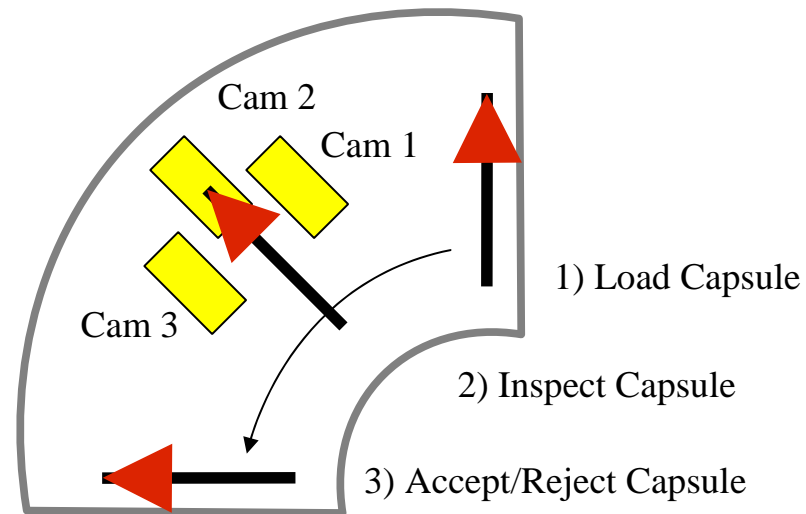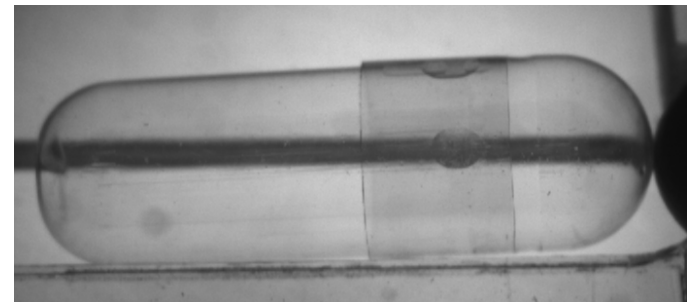
Fig 2. Optisorter Top View

Fig 3. Quadrant 1 detail: Operational Flow

Proposed System – Requirements

- Target Inspection rate of 1000 capsules per **minute**
- **Detect flaws including**
  - **Incorrect Size / Colour**
  - **Dents**
  - **Cracks / Surface flaws**
  - **Holes**
 - **Missing Cap**
 - **Closed Capsule**

Proposed System – Solution

- Full Custom solution
- Development of custom hardware
  - Cameras
  - System controller
- Development of custom firmware and software
- Use of PCs to acquire image data and perform inspection

Proposed System – Overview

- Four stations each with one host PC and 3 cameras.
- Stations communicate to System controller for triggers and accept and reject conditions
- System controller interfaces with Optisorter to control motor, actuators and switches.
- System controller also interfaces with Single board PC for external communication ie. Ethernet.
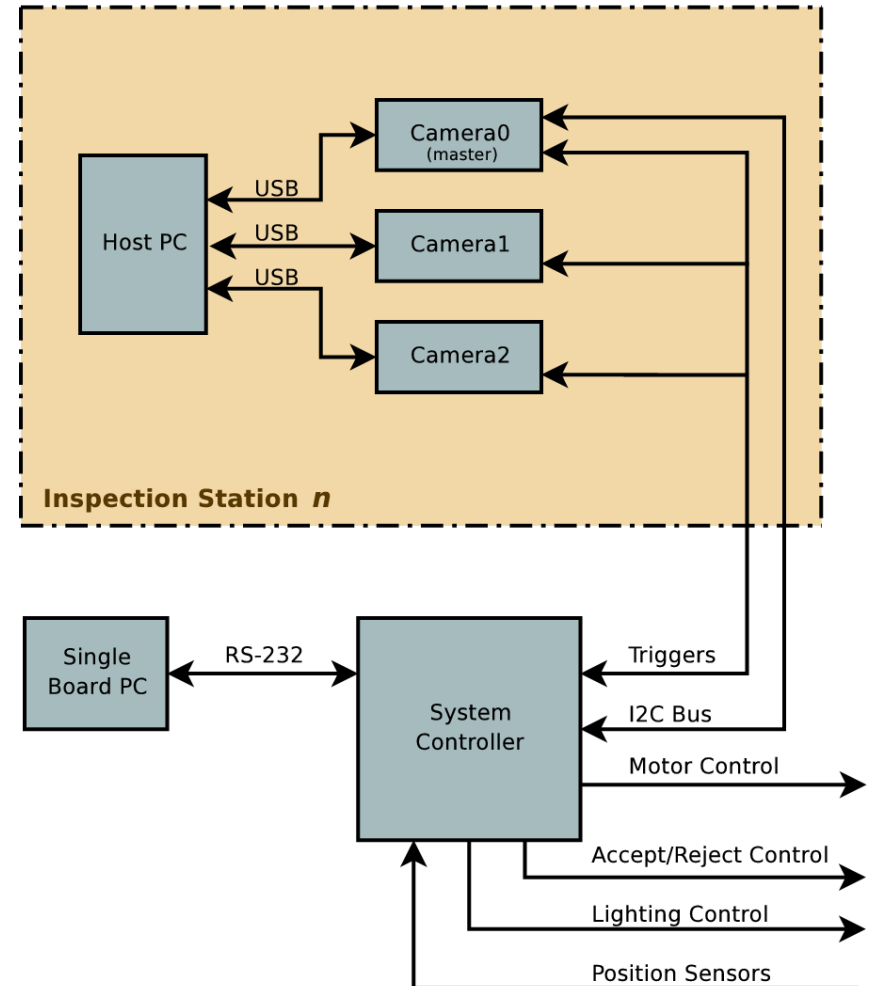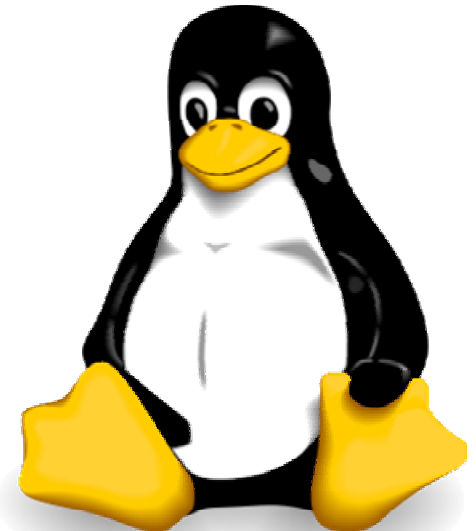
Proposed System – USB2.0 Camera
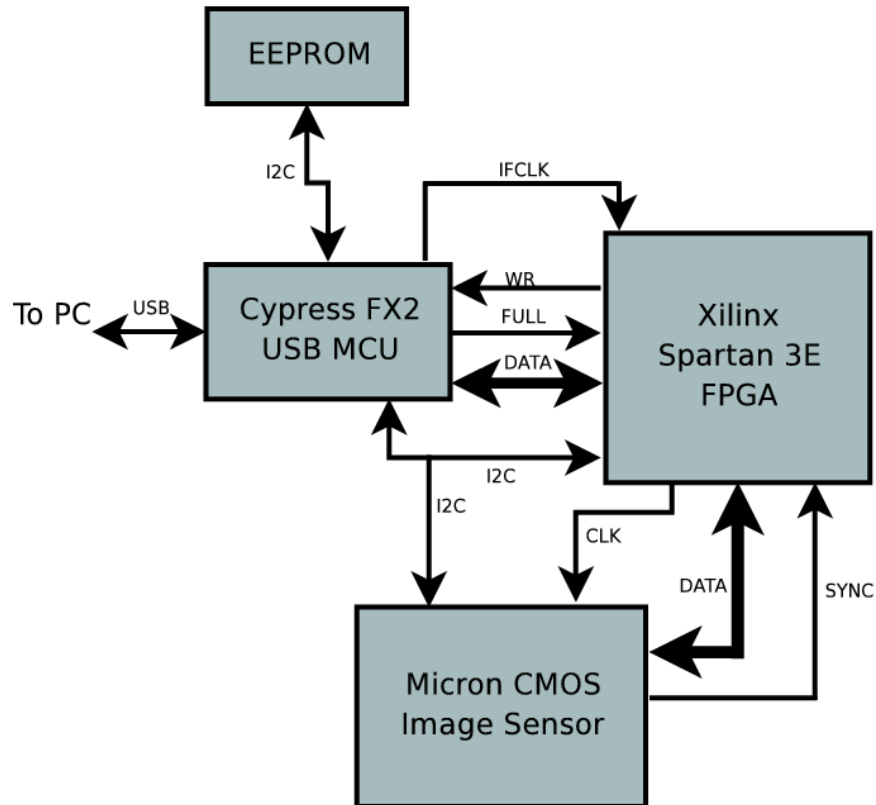
- Custom design phases
  - Hardware design
  - PCB layout
  - PCB fabrication and population
  - Testing and verification
- USB 2.0 Interface for image transfer
 - Reliable and Fast (480Mbps)
  - Abundant

Proposed System – Host PC

- Runs Linux distribution with 2.6 kernel
- Dedicated software running
    - Retrieves image data from USB cameras (using POSIX threads)
    - Performs inspection on all images acquired
    - Responds to the system with a pass / fail inspection result
- On system startup
    - Load firmware to all cameras

Proposed System – System Controller

- Operates system controls
  - Motor Control
  - Capsule Accept / Reject Controls
  - Illumination / Camera Triggering
  - Emergency Stop Control
  - Communication interface to cameras
  - Provides a user interface
  - UART module to communicate with PC
  - Provides expansion module
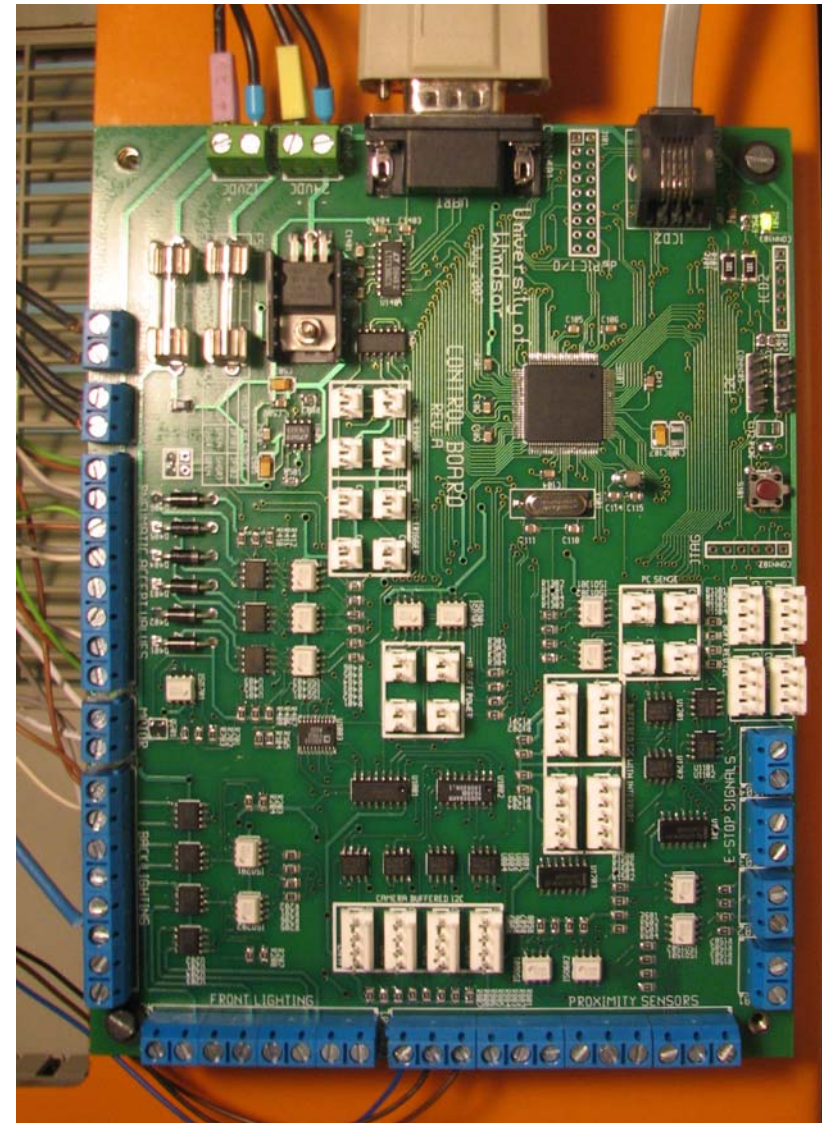
Proposed System – Camera

Custom USB Camera

- Fully customized hardware
- Fully customized operation

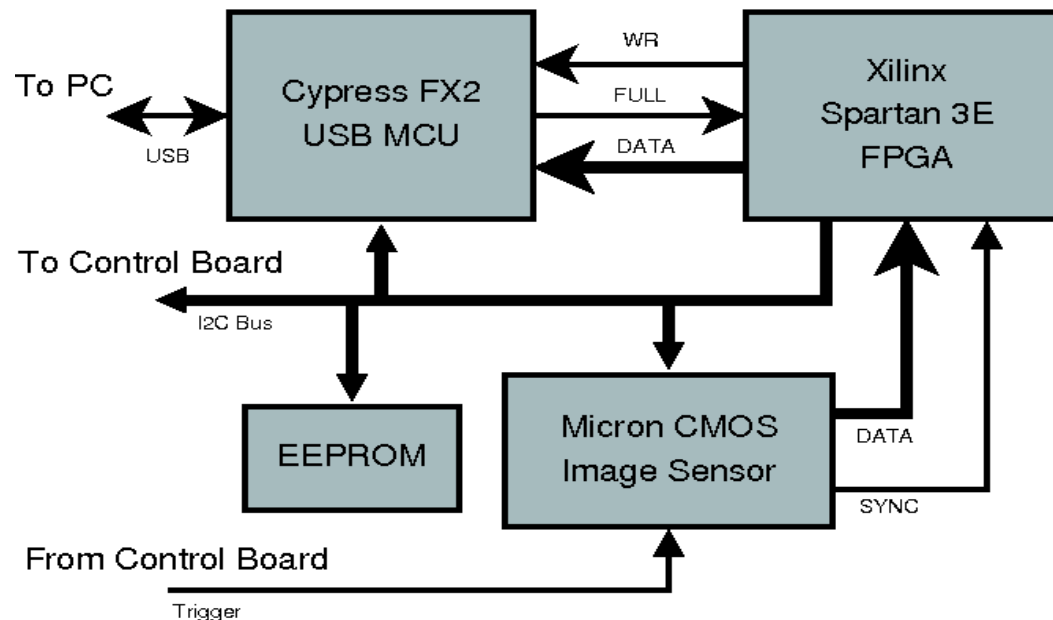### PROS

- Flexible
- Application optimized
- Low Cost

CONS

- Long development time

Proposed System – Camera

- FX2 to handle data transfer to PC

- Micron CMOS captures image data

- Xilinx FPGA for image processing and construction

- EEPROM for ID information

Proposed System – Camera

Custom USB Camera – FPGA Functions

- Image synchronization

- Image interpolation (demosaicing)

- Color conversion and image enhancement

- FIFO to buffer data to FX2

Incoming Light

Filter Layer

Sensor Array

Resulting Pattern

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